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ABSTRACT

The effect of limited faculty openings in high-ranked science departments on the self-esteem of graduates of prestigious research institutions was studied. Attention was also focused on the faculty productivity and participation in professional networks of these highly-qualified, new faculty who failed to secure an appointment in an elite institution. A total of 384 young, male scientists were studied, based on data obtained from the American Council on Education. To indicate self-perceived success, the respondent rated his own level of success relative to other male scientists with similar backgrounds. Measures of productivity and participation in networks were also evaluated using path analysis. Self-perceived success was more closely related to journal article productivity than to any other variables examined, with the exception of professorial rank and years of experience. Although data limitations preclude causal linking of self-esteem and networking with proposal writing and grant getting, it is suggested that the relationships are strong ones. It is concluded that young, highly-skilled academic scientists who find themselves removed, due to intense job competition, from the prestigious research centers should be aware that linkages with other scientists are essential to productivity and to self-esteem. (SW)

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SELF-ESTEEM, NETWORKS, AND PRODUCTIVITY IN ACADEMIC SCIENCE

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SELF-ESTEEM, NETWORKS, AND PRODUCTIVITY IN ACADEMIC SCIENCE

Sociologists of science have for some time observed the shifting academic marketplace with interest. Since the mid-sixties university scientists have been acutely aware of the disequilibrium created by production of more PhD's than the traditional academic market can accommodate. Declining undergraduate enrollments have produced fewer teaching appointments in universities and thus fewer career opportunities for holders of newly awarded doctoral degrees. In a study of recent trends in doctoral employment in the sciences, Robinson (1980) focused on the fact that sizeable numbers of doctoral graduates from the country's most distinguished research institutions are increasingly employed in less prestigious universities.

In a study for the National Science Foundation, Robinson found that in 1979 industry was the largest employer of scientists who received PhD's from the ten most prestigious institutions in the years between 1973 and 1979. These scientists comprised 31 percent of the doctoral output of the ten top institutions (up from 23 % in 1973). When combined with an additional number employed in government, cultural, and non-profit organizations, Robinson found that 45 percent of this PhD cohort were in careers outside of academe.

Both Robinson's study and the following discussion rest on some assumptions about prestige in doctorate granting institutions. For

some time the issue of institutional prestige has received attention in the literature, and various criteria have been advanced for establishing the prestige hierarchy (Cartter, 1966; Roose & Anderson, 1970; Muffo, 1979). Although there is disagreement about the most appropriate ranking criteria, substantial consensus exists with regard to the relative quality of various doctoral programs in science (Hartnett, Clark & Baird, 1978). A second related assumption is that the prestige of PhD granting departments is a powerful factor in academic hiring decisions. Whether a result of halo effect, objective evidence, an understandable desire on the part of hiring officials to minimize their risks, or more probably a combination of all of these factors, the notion that graduating from a prestigious program enhances one's value as an employee appears to have widespread acceptance, even though the relationship between prestige of doctoral program and eventual productivity remains unclear.

Returning to Robinson's study, in 1979 ten percent of the science graduates (1973 to 1979) of the ten most prestigious research institutions had entered faculties in one of these same universities, although not all were in tenure-track positions. Some were post-doctoral or other temporary appointments and it can be assumed that while many of these scientists will remain in the top institutions, some will eventually go elsewhere. An additional 13 percent entered faculties in one of the forty other academic

institutions classified as "Research University I" in the category system devised by the Carnegie Council on Policy Studies in Higher Education (1977). The Carnegie Council classified doctorate granting institutions into four categories on the basis of the amount of federal financial support and the number of PhD degrees awarded.

We have accounted for 68 percent of the 1973-79 graduates of the ten most prestigious schools. The remaining 32 percent of these scientists are employed elsewhere in academe, and are widely dispersed in universities and colleges across the country. It is this last one-third, the cohort of academic scientists who began their careers in institutions less prestigious than the research institutions in which they were trained and received their PhD's, who are the focus of our investigation.

Effects of Talent Dispersion

Consequences for Universities and Colleges

The dispersion of Top Ten scientists to less research-oriented colleges and universities can be expected to have significant short and long term effects on institutions and on individuals, and also has implications for research funding policy. What are the most likely consequences of this wide dispersion of talented scientists for the colleges and universities employing them? To the extent that prestige of graduate school and academic productivity of the graduate are related, this trend suggests an upgrading of faculty and staff at

these institutions. If, in hiring from the newly available pool of highly trained scientists, they choose to follow the pattern of more research-oriented universities, they may benefit from increased research capability and may gain status from the greater amount of publication associated with this research. The conditions under which these benefits may materialize, however, deserve consideration. Grant money for science research is currently relatively concentrated in the prestige institutions. Therefore pressure will have to be applied on government agencies, foundations, and other underwriters of research in order to secure access to the competitive arena in which available research monies are awarded. More proposals will have to be written by scientists in these schools, and proposal writing may make unaccustomed demands on the employing universities in terms of the various kinds of institutional support required.

A second set of conditions relates to the effects of dispersion of talent on the communication networks. Friedkin (1978) has hypothesized that academic decentralization has potential costs in terms of cohesion among the scientific elite--it may "thin out" the networks and ultimately constrain the flow of ideas and findings through the communication channels of science. Merton (1973) and others have suggested that scientific networks are a significant factor in the transmission of important ideas which may subsequently spur important research, and are the mechanism by which informal

feedback, recognition, and rewards are provided to researchers. In a climate of diminished fiscal resources, a cohesive elite may also be important in maintaining the relationship between researchers and policy makers who govern the distribution of monies for research.

Whether or not teaching will improve as a result of the dispersion of talent is problematic. The relationship between graduate preparation and effective teaching is still a matter of speculation. Muffo and Robinson (1981) suggest pessimistically that people trained to consider research and graduate teaching of paramount importance may become frustrated with teaching lower-aspiring undergraduates, this frustration resulting subsequently in discontent and poor quality teaching.

What are the likely outcomes of the talent dispersion for the most prestigious universities and colleges? The highest ranked schools in all categories (research, comprehensive, and liberal arts) have tended to increase the number of Top Ten doctoral graduates in science--the rich get richer—and there is no readily apparent near-term reason for this trend to dissipate.

Consequences for Individual Scientists

We focus now on our principal interest: the individual actors in this scenario of the changing academic marketplace. What are the likely consequences of talent dispersion for individual scientists caught in the interplay of supply and demand? Long (1978) suggests

that the university of a scientist's first employment is of immense importance in determining subsequent career productivity and thus in providing access to eventual recognition and rewards. For these Top Ten graduates, distress resulting from failure to secure a teaching appointment in a prestigious faculty, thus fulfilling their own high career expectations, may have important short and long term effects on self-conception. Kohn and Schooler (1982) have shown that psychic distress related to work orientation has the effect of decreasing self-directed behavior in the occupational setting. Reduction in productivity in terms of the amount of research, publication, proposal writing, grant getting, and networking efforts would appear to be a logical outcome of decreased self-directive occupational behaviors resulting from psychic distress associated with altered self-esteem in these scientists.

Further, over time, personality variables have important consequences for the individual's place in the work structure and for what Kohn and Schooler call "ideational flexibility"--performance in handling cognitive problems that require weighing both sides of an issue, differentiating figure from ground, and integrating parts into a meaningful whole--all essential capabilities for research scientists.

The importance of self-esteem is well known to researchers in psychology, and often discussed in the psychological literature.

Merton (1973) alludes to the importance of psychosocial processes, self-esteem among them, in the search for important scientific problems and the allocation of rewards, which in turn affect the flow of ideas and findings through the communication networks of science. The causes and effects of scientists' self-esteem have been infrequently explored. Of particular interest to us are the dynamic reciprocal relationships among self-esteem, social networking behaviors, productivity and research funding.

The relationships among these variables are particularly complicated because each involves a perplexing chicken or egg problem. Self-esteem is clearly both an antecedent and an outcome variable, and the process by which it interacts with social behaviors and productivity to produce increased self-esteem provides a basis for the accumulative advantage theory of productivity. Making some tentative assumptions about causes and effects, we have broken into the reciprocal relationships among these variables in order to examine some of their interactions.

Relative deprivation theory (Davis, 1966; Drew & Astin, 1972; Bassis, 1977) suggests that the self-concept of students in highly selective undergraduate environments is adversely affected by receiving relatively poorer grades than they initially expect and than they would have received at less selective colleges. The poorer grades then lead to lowered aspirations for graduate study and career

choice.

Insert Figure 1 about here

Transposing this algorithm to the realm of academic science, we propose that the self-esteem of young scientists trained in prestigious research institutions may be adversely affected by the intense competition for jobs in highly ranked science departments. Capable young PhD's who must settle for what they perceive as "second best" employment in less distinguished colleges and universities, in falling short of their own career expectations may suffer a diminished perception of self, which may ultimately contribute to lost productivity and hence reduced access to resources and rewards.

In addition to altered perceptions of self, dispersion may result in separation from supportive and stimulating professional interactions enjoyed as graduate students or post-doctoral fellows in distinguished research institutions, where the environment (and perhaps the size) appears to promote exchange among the faculty, and presents a field of opportunity that somehow promotes and energizes other opportunities inside and outside of those institutions.

Although there is evidence in studies of various disciplines that invisible colleges have tended to maintain themselves despite a lack of geographical proximity of their membership, it seems reasonable to

propose that as decentralization increases, networks involving the scientific elite may become less compact and less tightly meshed, and the nature of communications may consequently be altered.

Networking, the proclivity of a scientist to be connected to others in his discipline and/or other disciplines, depends on both psychic and social attributes of the individual. Altered self-conception may change a scientist's ability or desire to initiate or maintain professional connections with peers. On a more elemental level, networking is not without cost to the institution employing the scientist since it often involves time away from teaching or other campus responsibilities and travel expense. Distance, altered self-perceptions and disinclination of employing institutions to support networking efforts may thus affect an individual scientist's ability to maintain connections with others in science.

The foregoing discussion leads to our hypothesis: when a young member of the "science elite" fails to secure a faculty appointment in an elite institution, the reciprocal interactions of certain intrapsychic processes (self-esteem) and social behaviors (networking) may depress his productivity and adversely impact the entire system of science.

Method

A national sample of college and university faculty was available for this study. The data were collected in 1972-73 by the American

Council on Education (ACE), and have been used extensively since that time in sociological research focusing on academic life. From the original sample of 53,000 academics at 301 American institutions of higher education we randomly drew a one-third sample in order to reduce the computer resources involved. From the resulting sample we selected all the natural scientists who specified research as the principal activity of their employment, and also those who specified teaching or administration as their principal activity, but who in addition spent more than the median time in research specified by those for whom research was the primary activity. From this group we selected male scientists who have earned the PhD degree and were under forty years of age. This produced a sample of 384 young scientists for our investigation.

The single indicator of self-perceived success available in the ACE data was a question requiring the respondent to rate his own level of success relative to other male scientists of similar age, training and discipline. We used this measure recognizing that it is subject to an unknown amount of measurement error. Our measure of productivity was the number of articles published in journals since earning the PhD degree. We are aware that differences exist relative to levels of productivity in different disciplines (Allison & Stewart, 1974) and it may be worthwhile to examine the disciplines separately. Several networking indicators were available: the amount of time spent

away from campus for professional meetings, consulting, and other linking activities; sabbaticals; and the number of subscriptions to professional journals. Two frequently studied background variables (age and gender) were excluded from our analysis since they were controlled for in sampling, and marital status and race were unrelated to our dependent measures. Mother's education was included as a measure of social standing, and self-reported personal status vis a vis religion was also included. The technique of path analysis can be particularly useful in clarifying complex causal arguments, and for this reason a path analytic model was chosen for this study. Although the absence of longitudinal data and the constraints of secondary analysis prevent full testing of our hypothesis, worthwhile support is provided for the theoretical notion using the available cross-sectional data.

Findings

We examined the relative importance, for our sample of young scientists, of variables associated in previous research with journal article productivity (Wanner, Lewis & Gregorio, 1981). As the salience of additional variables was explored for this sample, self-perceived success was more closely related to journal article productivity than any other ascriptive or institutional variables examined, with the exception of professorial rank and years of experience, two highly interrelated factors. Table 2 shows the

zero-order correlation coefficients between journal article productivity, self-perceived success and the significant covariates identified in Wanner's research on determinants of productivity.

Insert Table 2 about here

Mean levels of self-esteem vary by discipline and are differentially related to scientists' publication productivity (e.g., r=.21 for physicists and .44 for bacteriologists).

When journal article productivity was regressed on the faculty characteristics in Table 2, only professorial rank, self-perceived success, and years of experience were significant predictors of productivity for this group of scientists. Table 3 shows the beta weights and F-values resulting from this regression.

Insert Table 3 about here

Contacts with other persons outside the immediate university environment who may serve as "evokers of excellence" (Merton, 1973) or simply as channels for communication of scientific information appear to have important effects on both publication productivity and self-esteem. Figure 4 shows that professional networking and "cosmopolitanism" achieved through participation in professional

organizations, speech-making, consulting, journal reading and other professional activities linking scientists in off-campus relationships are causal factors predicting both productivity and self-perceived success. The availability of time away from campus is a necessary but not sufficient condition for networking activities. In our path model (Figure 4) time is a dimension of both sabbaticals and away-from-campus professional activities.

Insert Figure 4 about here.

No conventional background factors were found to be significant determinants of journal article productivity, although they cannot be entirely dismissed, since their effects on productivity and self-esteem are very likely mediated by professorial rank and quality of institutional affiliation. Considering oneself a religious person entered (negative weight) regression equations predicting self-esteem, quality of institutional affiliation, and time spent in professional activities away from campus.

As suggested by relative deprivation theory, the negative path coefficient between institutional prestige and academic status (rank, tenure) is indicative of the fact that faced with greater competition it is more difficult for an academic scientist to achieve high status at a very prestigious university than a less prestigious one. The

effect of institutional prestige is to reduce the expected size of the path coefficients from academic status to productivity and self-esteem.

Discussion

We suggest that the path model shown in Figure 4, and also Bassis' relative deprivation model (Figure 1), are specific cases of a general causal model illustrating the negative effects of context pressures on competition outcomes and the resulting reduction in size of path coefficients to other dependent variables.

Insert Figure 5 about here.

In another special case (Figure 6) of the general model of competitive effects, competition for prestigious faculty appointments reduces the magnitude of path coefficients mediated by prestige of the obtained job, to networking variables, productivity, and self-esteem. Since self-esteem is an important determinant of productivity, the tight academic job market may have the effect of reducing self-esteem and long term productivity for a substantial number of able and highly trained scientists.

Insert Figure 6 about here

Determinants of Productivity: Previous Research

What accounts for the substantial differences in scientists' productivity? Two theories have been proposed by Cole and Cole (1973). The "sacred spark" hypothesis suggests that sustained scientific productivity may be the result of particularistic pre-career attributes of scientists (e.g., ability, motivation, and work-related drives and attitudes). While this explanation has intuitive appeal, problems in articulating constructs and resulting measurement difficulties have largely precluded its direct investigation.

The Coles have also proposed a second hypothesis known as "accumulative advantage", which explains productivity in terms of reinforcement theory. Scientists who publish results of significant research are rewarded by collegial recognition through citations in scientific journals, informal positive feedback, and formal awards. The need to maintain or enhance collegial esteem results in further research, publication, and rewards. In addition to the psychic benefits resulting from recognition by the larger scientific community, the credentialing effects of collegial recognition of published work appear to increase access to additional resources which facilitate further research and publication opportunities.

Reinforcement models logically imply increasing dispersion over time. Allison and Stewart (1974) confirm that accumulative advantage

has important effects on publication productivity over the entire career-span. While their work provides support for accumulative advantage, it does not disconfirm the sacred spark hypothesis. Substantial differences in early career productivity are not accounted for by accumulative advantage alone, and therefore either accumulative advantage operates from early life to account for differences at career entry or the differences must be attributed to ascriptive characteristics of individual scientists.

Academic rank, number of grants, and quality of institutional affiliation have been identified as significant predictors of journal article productivity (Wanner, Lewis, & Gregorio, 1981). The institutional prestige of a scientist's first post-Ph.D. employment and collegial recognition as measured by journal citations have also been identified as determinants of productivity (Reskin, 1977). Citations may be more important in maintaining productivity and self-esteem for researchers in small or geographically isolated departments than for scientists who work in large research centers and have the advantage of more or less continuous informal recognition and support from research-oriented colleagues. Reskin suggests that "any relatively stable propensity to publish probably depends on scientists' achievement needs, socialization, and a constellation of competing interests and activities". This propensity operates not in isolation, but in a context of varying resources and rewards.

The two notions, sacred spark and accumulative advantage, are not mutually exclusive and indeed seem to have synergistic effects. Self-esteem may be viewed as an element of both hypotheses and may in fact be the energy that drives accumulative advantage. The feedback loop that provides collegial recognition for significant contributions to science includes a mechanism for converting peer approbation to self-esteem. It is the powerful human desire to maintain or enhance self-esteem, or conversely the fear that declining productivity will result in peer disapprobation and thus in reduced self-esteem, that actuates further efforts at productivity.

The next question that must be asked is: what are the consequences for science productivity of behaviors that link scientists with other scientists in professional networks?

Effects of Networks on Productivity

We have defined networking behaviors as any actions that connect scientists with other scientists and tend to promote interaction in areas of common interest. We include in this definition: maintaining memberships in scientific or academic professional societies, contributing to and reading scientific journals, maintaining social relationships and professional associations outside of one's own department, participating in conferences, serving on editorial boards or as peer-reviewers for scientific journals, serving as reviewers of grant proposals, and other social linking behaviors that increase

awareness of scientific thought beyond one's immediate environment.

Networks influence scientists' productivity in at least two ways which are only peripherally related to their previously discussed function as channels for recognition of exemplary work. The first is their function as a communication system for scientific information. The Coles (1968) have studied a quality they call "awareness" of scientific research, and have found that, contrary to their expectations, physicists who taught at top-ranked departments had only slightly greater (r=.17) awareness of research in physics than their colleagues at lower ranking departments. Truly eminent physicists appear to be linked to the communication system regardless of the prestige of their department.

Professorial rank was the best (r=.28) single predictor of awareness, and the Coles suggest that the ability of rank to explain even this small percentage (.08) of the variance in awareness is due not to the prestige effects of rank, but to its interaction effects. Although no data are available to test this notion, full professors may have greater opportunities than others of lesser rank to serve on editorial boards, review proposals, supervise dissertations and be relieved of routine campus responsibilities to nurture linkages with cosmopolitan reference groups.

Seeking to explain awareness with little assistance from external or contextual variables, the Coles conclude:

> Those physicists who have done high quality work seem to have relatively high awareness even if they work in undistinguished departments. We would guess that productive men at low ranking departments have cosmopolitan reference groups and thus find it easier to keep up with what is going on in their field than their colleagues whose work has been less significant (p 407).

In addition to their importance in serving as channels for the transmission of scientific information and sources of recognition and reinforcement, networks encourage productivity through sanctions. Anticipated or real sanctions provide strong motivation. Scientists may fear that colleagues will view them as failures if their productivity declines. The less integrated into networks a scientist is the less important these sanctions become, for fewer colleagues will judge him, but also the less he is in touch with what is happening in his discipline, and the less likely he is to receive the collegial recognition that, mediated by self-esteem, impels and rewards future productivity.

Implications

Despite sophisticated research design and an abundance of carefully collected data, no comprehensive model of scientific productivity has emerged. In the search for causes and effects of productivity, attention is commonly focused on external variables. We

suggest that ultimately any satisfactory theory of productivity will integrate ascriptive, psychosocial, and context variables, and the notion of multiplicative advantage. This paper has pointed to the importance of psychosocial factors--networking and self-esteem. For science to be advanced it is not enough for new ideas to be generated and new experiments performed. The innovations must be communicated to others in order to become part of the common fund of scientific knowledge available to other scientists. Communication implies not only visibility but awareness, and both require effort. Young highly-skilled academic scientists who find themselves removed, due to the vagaries of supply and demand, from the prestigious research centers should be aware that forging linkages with other scientists is essential to productivity and thus to self-esteem. Self-esteem is good for science; it allows scientists to take risks, and thus promotes productivity.

Although limitations in our data preclude causal linking of self-esteem and networking with proposal writing and grant getting, our logic leads us to suggest that the relationships are strong ones. Networking requires time and effort and at least a modicum of social skill, but academic researchers who want to remain in the mainstream of science must make the effort. Institutions employing these highly skilled young scientists should clearly perceive that grants go to scientists who have time available for making connections, and by

providing this resource they will build their own research capabilities and reputations.

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FIGURE 1. Path model specifying the impact of college selectivity on the academic self-evaluations of college freshmen (Bassis)

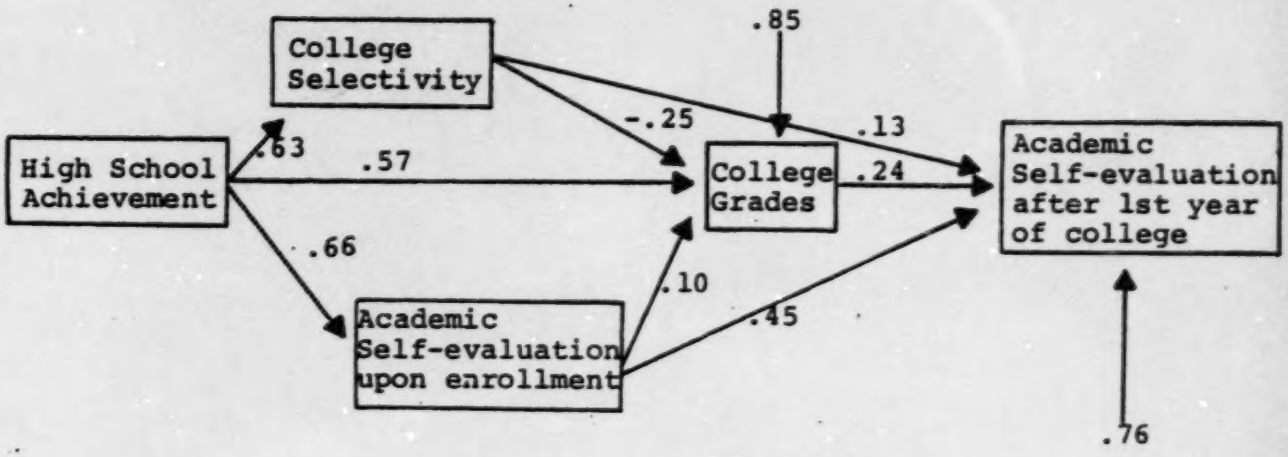

TABLE 2. Coefficients of Correlation Between Productivity and Potential Determinants

Independent Variable	Correlation with Productivity
Rank	.59
Years of experience	.37
Self-perceived success	.35
Journal subscriptions	.21
Quality of institution	.11

TABLE 3. Standardized Regression of Number of Articles on Faculty Characteristics

Independent Variable	Beta Weight	F-Value
Rank	.45*	63.17
Self-perceived success	.20*	15.79
Years of experience	.13*	5.83
Quality of institution	.07	2.31
Journal subscriptions	.06	1.58

FIGURE 4. Path model specifying the impact of institutional prestige, academic status and networking variables on journal article prcductivity and self-esteem

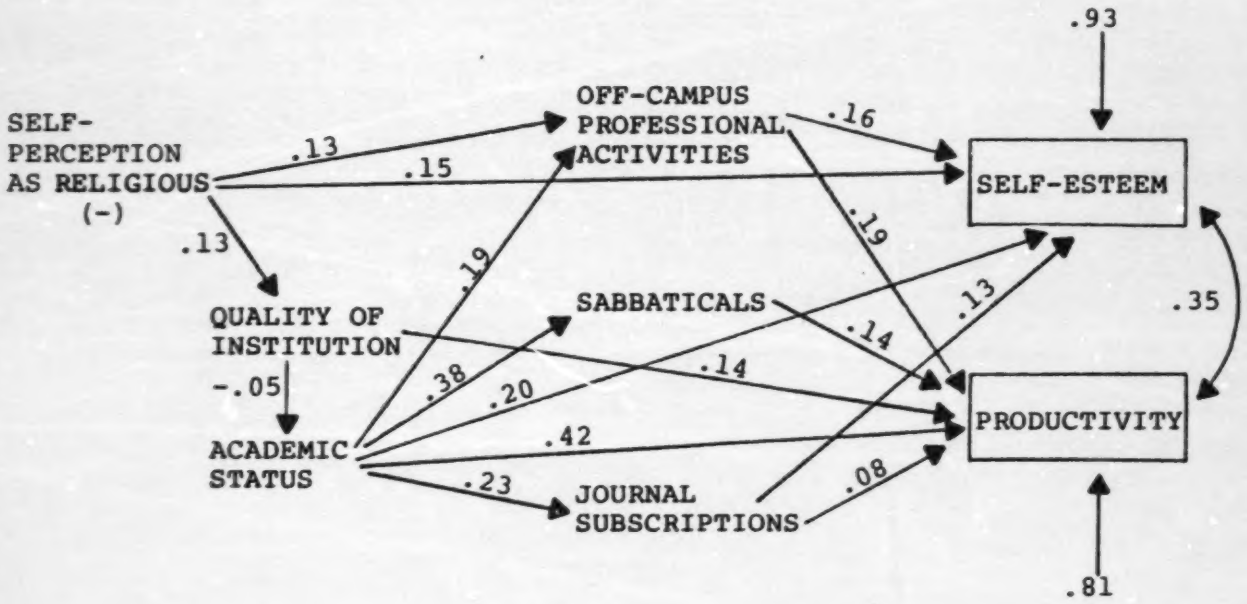

FIGURE 5. Path model illustrating negative effect of competitive context on competition outcome and indirect effect on dependent variables mediated by outcome [A + (B*C)]

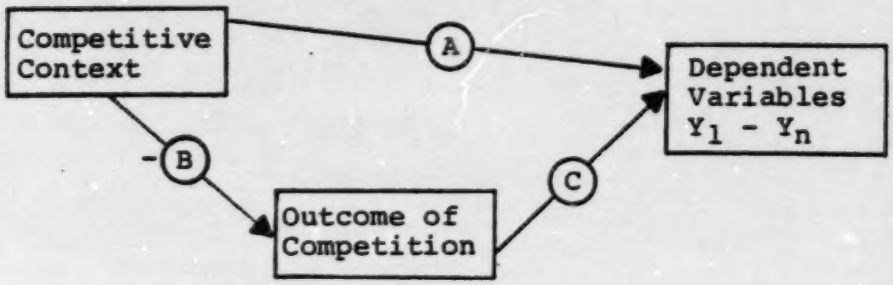

FIGURE 6. Path model illustrating negative effect of competitive academic job market on quality of position obtained and indirect effect of competition on networking, productivity, and self-esteem